VRU Systemic Safety near Bus Stops Project

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MassDOT
Agenda

1. VRU Background
2. Systemic Approach to Bus Stops
3. FY24 Bus Stop Process
4. Bus Stops Looking Forward
Vulnerable Road User (VRU) Assessment

Program of Strategies

1. Implement site-specific projects
2. Implement systemic projects
3. Material procurement
4. Support the Top 5 Percent VRU Communities for Targeted VRU Projects
5. Prioritize Projects based on Community Risk Factors
A Systemic Safety Approach to VRU Implementation

- Multi-year program using VRU HSIP Funding
- To deliver a first year project, bus stops on state-owned roadways were looked at first

Source: FHWA Systemic Safety Project Selection
Identify Focus Crash Type and Risk Factors (Step 1)

40% of Pedestrian crashes (involving fatal or serious injury) were within 300 ft of a bus stop

*only 6% of roadway centerlines in Massachusetts are within 300’ of a bus stop
Screen and Prioritize Candidate Locations (Step 2)
Spatial Data and Stakeholder Input Driven Process

- MassDOT Jurisdiction
- Confirmed bus stop or flag stop
Screen and Prioritize Candidate Locations

Screening using GIS data:
- Primary risk segment or intersection of pedestrians
- High potential for everyday walking
Screen and Prioritize Candidate Locations

Screen out Existing Projects:
- Projects programmed in the Current STIP were reviewed to ensure designs improved bus stop safety sufficiently
- If that project could not achieve desired safety, those bus stops went back into the VRU Candidate Pool
## Select Countermeasures (Step 3)

### FY24
- Existing crosswalk enhancements
  - Median Refuge
  - Visibility improvements
  - Curb extensions
  - RRFBs
  - Signage
- New Unsignalized Crosswalks that do not require a PHB or pedestrian signal
- Speed Management
  - Speed Humps
  - Speed Feedback signs
  - Neck-down/Chicane

### FY25 beyond
- Municipal locations
- Bus Stop Relocations
- Road Diets
- LPIs
- New Crosswalks at Signals
- PHBs or pedestrian signals
- New Lighting
- Raised crossings
- New bus stops (replacing flag)

**Triggers:**
ROW easements, public process, traffic counts/analysis, significant utility work
### Table 1. Application of pedestrian crash countermeasures by roadway feature.

<table>
<thead>
<tr>
<th>Roadway Configuration</th>
<th>Posted Speed Limit and AADT</th>
<th>Vehicle AADT &lt;9,000</th>
<th>Vehicle AADT 9,000–15,000</th>
<th>Vehicle AADT &gt;15,000</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>≤30 mph</td>
<td>35 mph</td>
<td>≥40 mph</td>
</tr>
<tr>
<td>2 lanes (1 lane in each direction)</td>
<td></td>
<td>1 2 3</td>
<td>4 5 6</td>
<td>7 8 9</td>
</tr>
<tr>
<td>3 lanes with raised median (1 lane in each direction)</td>
<td></td>
<td>1 2 3</td>
<td>4 5 6</td>
<td>7 8 9</td>
</tr>
<tr>
<td>3 lanes w/o raised median (1 lane in each direction with a two-way left-turn lane)</td>
<td></td>
<td>1 2 3</td>
<td>4 5 6</td>
<td>7 8 9</td>
</tr>
<tr>
<td>4+ lanes with raised median (2 or more lanes in each direction)</td>
<td></td>
<td>1 2 3</td>
<td>4 5 6</td>
<td>7 8 9</td>
</tr>
<tr>
<td>4+ lanes w/o raised median (2 or more lanes in each direction)</td>
<td></td>
<td>1 2 3</td>
<td>4 5 6</td>
<td>7 8 9</td>
</tr>
</tbody>
</table>

Given the set of conditions in a cell.

- **Signifies that the countermeasure is a candidate treatment of a marked uncontrolled crossing location.**
- **Signifies that the countermeasure should always be considered, but not mandated or required, based upon engineering judgment at a marked uncontrolled crossing location.**
- **Signifies that crosswalk visibility enhancements should always occur in conjunction with other identified countermeasures.**
- The absence of a number signifies that the countermeasure is generally not an appropriate treatment, but exceptions may be considered following engineering judgment.

### Table 2. Safety issues addressed per countermeasure.

<table>
<thead>
<tr>
<th>Pedestrian Crash Countermeasure for Uncontrolled Crossings</th>
<th>Safety Issue Addressed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crosswalk visibility enhancement</td>
<td>Conflicts at crossing locations</td>
</tr>
<tr>
<td>High-visibility crosswalk markings*</td>
<td></td>
</tr>
<tr>
<td>Parking restriction on crosswalk approach*</td>
<td></td>
</tr>
<tr>
<td>Improved nighttime lighting*</td>
<td></td>
</tr>
<tr>
<td>Advance Yield Here To (Stop Here For) Pedestrians sign and yield (stop) line*</td>
<td></td>
</tr>
<tr>
<td>In-Steel Pedestrian Crossing sign*</td>
<td></td>
</tr>
<tr>
<td>Curb extension*</td>
<td></td>
</tr>
<tr>
<td>Raised crosswalk</td>
<td></td>
</tr>
<tr>
<td>Pedestrian refuge island</td>
<td></td>
</tr>
<tr>
<td>Pedestrian Hybrid Beacon</td>
<td></td>
</tr>
<tr>
<td>Road Diet</td>
<td></td>
</tr>
<tr>
<td>Rectangular Rapid-Flashing Beacon</td>
<td></td>
</tr>
</tbody>
</table>
Countermeasures: STEP Guidelines

Table 1. Application of pedestrian crash countermeasures by roadway feature.

- Determine if new crosswalks can be safely added
- At certain combinations of volumes, speeds, and # of lanes, a crosswalk requires more than a warning device (RRFB) to meet guidelines
  - Used INRIX and MS2
  - Collected data when needed
Countermeasures: Crossing Methodology

1. Determine if a crosswalk is serving desire lines of bus stop (CW within 200')

   - Existing crosswalk within 200' and is closer than nearest intersection
     - Mid-block and unsignalized intersection
     - Signalized intersection
     - Consider relocation of bus stop
     - Evaluate STEP Guidelines for a new crosswalk**
     - 4-way STOP?
       - Uncontrolled
       - Table for FY25 to see if crosswalk can be added at signal
     - Table for FY25 to review phasing and LPI potential
   - There is no nearby intersection
     - Evaluate STEP to see if a crosswalk can be added in FY24**
   - No, nearest intersection is unsignalized without a crosswalk
     - No, nearest intersection is a signal that does not have a crosswalk
       - Add a crosswalk
       - Evaluate STEP to see if a crosswalk can be added in FY24**
       - Consider relocation of bus stop

2. Goal: Utilize VRU Bus Stop Map data to systemically determine crosswalk need in a spreadsheet

3. Inputs: Distance from bus stop to nearest crosswalk, intersection, and signal (manual data collection)
## Countermeasures: Crossing Methodology

<table>
<thead>
<tr>
<th>FY24 Candidate</th>
<th>Crosswalk Design</th>
<th>Distance from Intersection (FT)</th>
<th>Distance from Signal (FT)</th>
<th>Distance from crosswalk (FT)</th>
<th>Bus Stop ID KI</th>
<th>AADT</th>
<th>Speed Limit Est</th>
<th>Speed Limit Reg</th>
<th>STEP Guidance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>New Crosswalk</td>
<td>299 299 299</td>
<td></td>
<td>5287</td>
<td>19745</td>
<td>40</td>
<td></td>
<td>40</td>
<td>NO CW AADT&gt;15000 and Speed&gt;=40mph</td>
</tr>
<tr>
<td>Yes</td>
<td>New Crosswalk</td>
<td>540 540 540</td>
<td></td>
<td>5337</td>
<td>19745</td>
<td>40</td>
<td></td>
<td>40</td>
<td>NO CW AADT&gt;15000 and Speed&gt;=40mph</td>
</tr>
<tr>
<td>Yes</td>
<td>New Crosswalk</td>
<td>640 980 980</td>
<td></td>
<td>5471</td>
<td>30164</td>
<td>40</td>
<td></td>
<td>40</td>
<td>NO CW AADT&gt;15000 and Speed&gt;=40mph</td>
</tr>
<tr>
<td>Yes</td>
<td>New Crosswalk</td>
<td>460 450 460</td>
<td></td>
<td>6087</td>
<td>23813</td>
<td>40</td>
<td></td>
<td>40</td>
<td>NO CW AADT&gt;15000 and Speed&gt;=40mph</td>
</tr>
<tr>
<td>Yes</td>
<td>Existing Crosswalk</td>
<td>36 9999 36</td>
<td></td>
<td>4089</td>
<td>2950</td>
<td>35</td>
<td></td>
<td>35</td>
<td>NO CW AADT&gt;15000 and Speed&gt;=40mph</td>
</tr>
<tr>
<td>Yes</td>
<td>Existing Crosswalk</td>
<td>0 9999 193</td>
<td></td>
<td>4351</td>
<td>6115</td>
<td>35</td>
<td></td>
<td>35</td>
<td>NO CW AADT&gt;15000 and Speed&gt;=40mph</td>
</tr>
<tr>
<td>Yes</td>
<td>New Crosswalk</td>
<td>390 390 390</td>
<td></td>
<td>4484</td>
<td>10924</td>
<td>35</td>
<td></td>
<td>40</td>
<td>OK</td>
</tr>
<tr>
<td>Yes</td>
<td>Existing Crosswalk</td>
<td>0 700 226</td>
<td></td>
<td>4665</td>
<td>898</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>Existing Crosswalk</td>
<td>350 350 110</td>
<td></td>
<td>4683</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>New Crosswalk</td>
<td>260 250 9999</td>
<td></td>
<td>4646</td>
<td>20943</td>
<td>35</td>
<td></td>
<td>35</td>
<td>NO CW 35mph and 4+ lanes</td>
</tr>
<tr>
<td>Yes</td>
<td>Existing Crosswalk</td>
<td>240 310 0</td>
<td></td>
<td>6129</td>
<td>9935</td>
<td>30</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>New Crosswalk</td>
<td>650 9999 28000</td>
<td></td>
<td>2505607</td>
<td>6835</td>
<td>45</td>
<td></td>
<td>45</td>
<td>OK</td>
</tr>
<tr>
<td>Yes</td>
<td>New Crosswalk</td>
<td>330 9999 27850</td>
<td></td>
<td>2505608</td>
<td>6835</td>
<td>45</td>
<td></td>
<td>45</td>
<td>OK</td>
</tr>
<tr>
<td>Yes</td>
<td>New Crosswalk</td>
<td>120 9999 25175</td>
<td></td>
<td>2505609</td>
<td>6125</td>
<td>40</td>
<td></td>
<td>40</td>
<td>OK</td>
</tr>
</tbody>
</table>

Some FY24 candidates for new crosswalks required more than an RRFB and were removed from FY24 candidate list list.
Countermeasures: Non-Crossing Considerations

**Speed Management**
- INRIX Speeds >> Posted Speed Limit
- Primary Risk for Speeding
- Location that does not meet criteria for a new FY24 midblock crosswalk per STEP due to speeds

**Accessibility**
- Existing ramps in poor condition per database
- Obstruction to bus stop noted by reviewers
- Existing medians with barriers or lack of curb cuts

**Visibility Issues**
- Advanced warning signage for horizontal and vertical geometry challenges
- Tree trimming

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**Data Collection**
- Bus Stop Sign
- Bus Shelter
- Bus Stop Pairs
- Nearby Intersection Control
- Roadway width
- Existing Ped Warning Sign
- Existing Cross Walk
- Existing Curb Ramp
- Shoulder Width
- Lighting
- Median Type
- Number of Travel Lanes
- Curb
- Visibility Issues
- Safe Waiting area

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[Logo: U.S. Department of Transportation Federal Highway Administration]
Countermeasures: Partnering with Research

Coordinating with the Every Day Counts (EDC) Nighttime visibility for Safety initiative

Piloting textured transverse paint (will be black) for audible warnings to drivers
Prioritize Candidate Locations (Step 4)

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>740</td>
<td>• VRU bus stops on SHLO first pass</td>
</tr>
<tr>
<td>575</td>
<td>• VRU bus stops confirmed for jurisdiction and validity with RTA</td>
</tr>
<tr>
<td>212</td>
<td>• VRU bus stops confirmed, not within 250’ of a signal</td>
</tr>
<tr>
<td>158</td>
<td>• FY24 candidate list, paired bus stops at unsignalized locations</td>
</tr>
<tr>
<td>73</td>
<td>• 10% Concepts submitted</td>
</tr>
</tbody>
</table>

“Prioritization by FY24 Natural Selection”
- Only 5% of VRU bus stops are on SHLO
- Design and timeframe constraints limited us such that we did not need to “prioritize”
  - Removal of signals
  - Identification of unmapped overlapping efforts
  - QC of road inventory/GIS data by designers
  - New crosswalks not allowed per STEP

Prioritization will be much more of a critical step for municipal bus stops
### Streamlined Process: Design Documentation

#### General Project Location Information

<table>
<thead>
<tr>
<th>Municipality:</th>
<th>LENOX</th>
</tr>
</thead>
<tbody>
<tr>
<td>Major Street:</td>
<td>PITTSFIELD ROAD / ROUTE 20</td>
</tr>
<tr>
<td>Functional Classification:</td>
<td>Rural or urban principal arterial</td>
</tr>
<tr>
<td>Minor Street:</td>
<td>West Mountain Rd</td>
</tr>
<tr>
<td>Type:</td>
<td>Mid-block</td>
</tr>
</tbody>
</table>

#### Existing Conditions & Data Collection

| Speed Reg. | 40 |
| Speed Limit | - |
| Volume:     | 21761 |
| ROW Info:   | Survey - CAD 2012 | 606544 |
| Speed (M/T): | 3453604 | 3453605 |
| Speed (M/T): | 3453604 | 3453605 |

- **Notes:** Slight vertical curve with a significant horizontal curve for SB approach. Sight distance for SB approach was 385’. Posted 40 MPH speed limit. NB/SB traffic appeared in traffic waves due to light cycles. Vast majority of drivers did not appear to acknowledge field staff waiting to cross roadway. Two street lights present but not adequate for pedestrian safety.

- **Designer inputs Bus Stop ID Key(s) here and all fields in white auto-populate from the GIS map**

- **Design template reviewed with MassDOT HQ**

- **Review Sections ahead of time**
Streamlined Process: Design Documentation

**Documentation of proposed design decisions**

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### Example

**Table 1. Application of pedestrian crash countermeasures by roadway feature.**

<table>
<thead>
<tr>
<th>Roadway Configuration</th>
<th>Pedestrian AADT</th>
<th>Pedestrian AADT</th>
<th>Vehicle AADT</th>
<th>Vehicle AADT</th>
<th>Pedestrian AADT</th>
<th>Pedestrian AADT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>600 or less</td>
<td>750 or less</td>
<td>&gt; 750</td>
<td>&gt; 750</td>
<td>600 or less</td>
<td>750 or less</td>
</tr>
<tr>
<td>2 lanes</td>
<td>5 mph</td>
<td>15 mph</td>
<td>30 mph</td>
<td>40 mph</td>
<td>5 mph</td>
<td>15 mph</td>
</tr>
<tr>
<td>3 lanes</td>
<td>4 mph</td>
<td>10 mph</td>
<td>20 mph</td>
<td>30 mph</td>
<td>4 mph</td>
<td>10 mph</td>
</tr>
<tr>
<td>4 lanes</td>
<td>3 mph</td>
<td>8 mph</td>
<td>15 mph</td>
<td>20 mph</td>
<td>3 mph</td>
<td>8 mph</td>
</tr>
</tbody>
</table>

---

**Notes:**

Curb extensions considered due to speeds observed higher than speed limit for speed management and pedestrian visibility. Concerns about bike infrastructure were expressed so a proposed design with a bike ramp up to a off road bike lane was proposed.
Streamlined Process: INRIX Speed Data Validation

- Use what we had (INRIX and Speed Regs) to inform concepts
- Gather speed data when needed, per OTS comments and field visits
- Re-evaluate design
- Add speed management
- Target speeds

10% OTS

25/75%

Shout out to John Amato for the help!
Streamlined Process: INRIX Speed Data Validation

OTS Comment:

D5 TRAFFIC: MS2 data on North Pearl Street north of Pleasant Street (Count Station 3372899) estimates the 2022 AADT to be 15,122. With two lanes and a posted speed of 40 mph, the STEP guide does not include RRFBs as a candidate treatment. Please confirm volumes and speeds at this location.

INRIX had showed 33mph (75th) and 37mph (95th)

Speed data collected:
85th percentile 42 mph,
ADT over 15,000

25/75% design adjustments:
• Speed feedback signs
• Transverse textured paint
• Corridor speed management
Streamlined Process: Survey Approach

- Performed field visits to ensure that proposed designs were constructable (Book Job +)
- GIS map identified recently constructed projects/unprogrammed projects in design so that existing survey could be used
- Included SHLO in OTS for verification of where no survey was needed
- Requested two types of survey – ROW and Design

<table>
<thead>
<tr>
<th>Survey Approach</th>
<th># Locations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing Survey</td>
<td>8</td>
</tr>
<tr>
<td>Survey Conducted – ROW</td>
<td>19</td>
</tr>
<tr>
<td>Survey Conducted – Design</td>
<td>16</td>
</tr>
<tr>
<td>No Survey Needed</td>
<td>9</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>52</strong></td>
</tr>
</tbody>
</table>

Survey is expected in the next few weeks and will verify if 35 of these 25/75% project locations can indeed be delivered!
FY24 Bus Stops Timeframe

- **July 2023**: Assessment identified bus stop trend
- **August 2023**: Initial meetings with RTAs
- **September 2023**: Desktop data collection → FY24 Candidates (158)
- **December 2023**: 10% concepts submitted (73)
- **March 2024**: 25/75% submission (52)
- **July 2024**: Anticipated 100%/PS&E (??)
- **May 2024**: Anticipated survey
## Successes & Challenges from FY24 so far

### Successes
- Bus Stop Data Cleanup
- RTA/RPA Collaboration
- Utilizing Data in one GIS map and for collaboration
- Leveraging in-house resources
- Paving the way for streamlined process! (We hope/think!)
- Piloting new safety countermeasures

### Challenges
- Survey timing
- Lack of a standard process for streamlined design
- Facilitating municipal-level feedback due to number of locations
- Friction between speed management needs and maintenance concerns
Bus Stops Looking Forward: DOT-owned signals

**Candidate Signals near VRU Stops**

- **Critical* Crosswalks Missing**: 37
- **Non-Critical Crosswalk(s) Missing**: 59
- **All Legs have Crosswalks**: 92

*Critical defined as:

- Sidewalk on both sides and no way to cross the street
- Paired bus stop with no crosswalk between
- A bus stop on one side of the street and points of interest on the other that would create a desire line with no crosswalk
Bus Stops Looking Forward: DOT-owned signals

Missing Crosswalks

- Assuming a budget of $3M construction, approximately 20 locations
- Utilized AI Crosswalk inventory and GIS map
- Sent candidate list to Districts for comment; working through proper scope for D6
- Goal: New crosswalks at signals where crosswalks do not exist

Other Signal Modifications

- Changing phasing/timing for existing crosswalk phases
- Protected Left Turns, NROR
- Pavement Markings
Bus Stops Looking Forward: Municipal owned roadways

Identified Need for Unique Prioritization Methodology

• 80% of all bus stops are municipally owned
• If you use the same criteria from SHLO, you get 6,500 “VRU bus stops”
• Consultants to coordinate with RTAs, MPOs, and Towns on prioritization methodology that is regionally equitable
• Ridership, where available, likely to be included

Continuing to leverage data

• AI crosswalk presence incorporated
• Nearest intersection and nearest signalized intersection added from MIRE inventory
Example: Adding crash into methodology brought Berkshire municipal VRU bus stop total from 67 to only 6 into only one pedestrian cluster in the region.
Systemic Safety Improvement Model Built(-ish), What's Next?

Rinse, recycle, repeat!
Thank you! Let’s keep going!

- In-House Design: led by Maddie DeClerck
- Consultants: Toole Design
- HQ Safety led by Bonnie Polin
- FY24 PM: Koby Lemrise
- Districts, RTAs, RPAs
- Survey & ROW
- Everyone else!
Questions?

VRU Safety near Bus Stops Project

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